

## Autochthonous, Non Carbonates Sedimentary Rocks

- These rocks include:
  1. Evaporites.
  2. Phosphates.
  3. Sedimentary ironstones.
  4. Coal.
  5. Siliceous sedimentary rocks.



## EVAPORITES

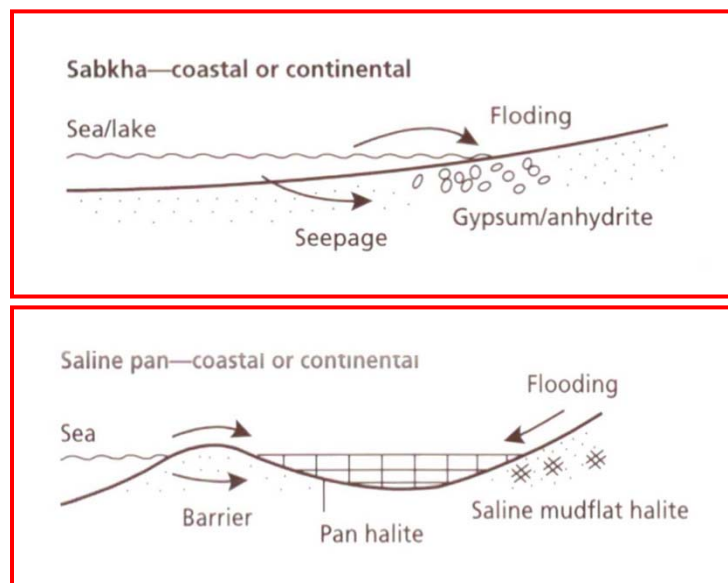
- Chemically precipitated sediments.
- The principal evaporite minerals are:
  - 1. gypsum ( $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$ ).
  - 2. anhydrite ( $\text{CaSO}_4$ ).
  - 3. halite ( $\text{NaCl}$ ).
- Evaporites deposition following two principal modes:
  - 1. subaerial precipitation (e.g. sabkhas).
  - 2. subaqueous precipitation.



## Modes of evaporite deposition

- Subaerial precipitation, taking place within sediment (sabkhas) or in very shallow to desiccated saline pans. They formed under evaporative, arid conditions (hot and arid climate).
- Subaqueous precipitation, from a shallow to deep water body, in a small (lake /lagoon) to large (intracratonic /rift basin) scale.

## Subaerial precipitation



## Subaqueous precipitation

➤ In marine setting, some barrier is required to allow the water to evaporate to high salinities, but periodic replenishment of the brine body is necessary too.

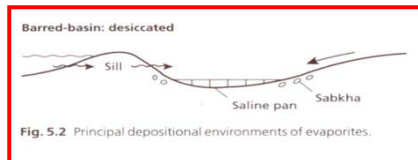
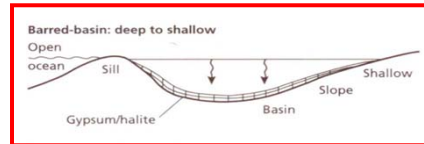
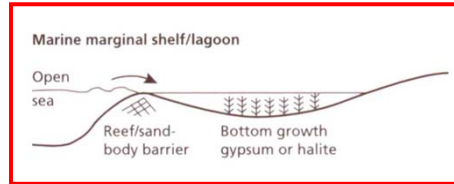


Fig. 5.2 Principal depositional environments of evaporites.

➤ The evaporite minerals may be reworked by waves and storms in shallow water, and re-sedimented off slopes by slumps, debris flows and turbidity current in deeper water.

## EVAPORITES

- Gypcrete or gypsite is indurated crust of evaporites in soil of desert area.
- Evaporite deposits are commonly cyclic (numerous thin evaporite beds alternating with limestone and marl).
- Evaporites are common cap rocks to carbonate reservoir or effecting structural traps through salt diapirism.



## **Sedimentary Phosphate Deposits**

**Sedimentary phosphate deposits (or phosphorites) are important natural resources:**

- **One of the chief constituents of fertilizers.**
- **Contain U, F, V and other useful elements, and are used widely in the chemical industry.**
- **Commonly associated with organic-rich mudstones, which are potential hydrocarbon source rocks.**

## **MINERALOGY**

- **Most sedimentary phosphates are carbonate hydroxyl fluorapatites**
  - **Francolite (F>1%, and appreciable carbonate , anisotropic).**
  - **Dahllite (F< 1% with carbonate hydroxyapatite, anisotropic).**
  - **Collophane (cryptocrystalline, isotropic).**
- **Calcium in phosphate may be substituted by Na, Mg, Sr, U and rare earths.**

## Three main types of sedimentary phosphate deposits

- **Nodular and bedded phosphorites.**
- **2. Bioclastic and pebble-bed phosphorites.**
- **3. Guano.**

### 1. Nodular and Bedded Phosphorites

- **Formed by upwelling and organic productivity.**
- **Upwelling means: cold waters containing nutrients rise from the depths towards the surface.**
- **This causes high organic productivity and phytoplankton growth in surface water.**
- **The net result is oxygen-deficient water and then phosphate-enriched sediments are formed.**

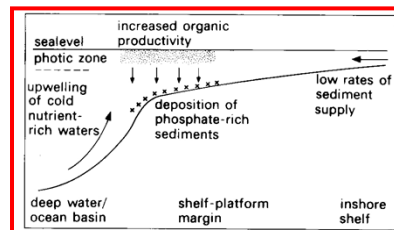


Fig. 7.2 Model for formation of marine phosphorites.

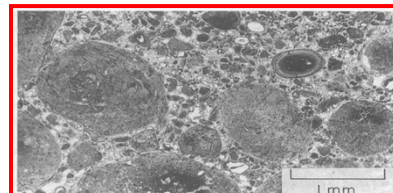


Fig. 7.3 Phosphorite pellets in matrix of smaller pellets and cryptocrystalline collophane. An ooid of collophane is also present. Plane-polarized light. Phosphoria Formation, Permian, Idaho, USA.

## 2. Bioclastic (Bone-bed) and Pebble-bed Phosphorites

- Vertebrate skeletal fragments are locally concentrated to form bone beds.
- This mainly by the effect of current and wave reworking of sediments and winnowing of finer material, such that the phosphatic grains are left as lag deposits.
- These conditions are favorable in transgressive-regressive shelf and shore zones, and fluvial and intertidal channels.
- This phosphate may associate the upwelling phosphate.

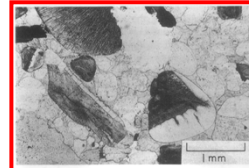


Fig. 7.5 Photomicrograph of bone fragments showing internal structure, in calcite-cemented sandstone. Plane-polarized light. Rhaetic bone bed, Upper Triassic, Gloucestershire, England.



Fig. 7.4 Bioclastic phosphorite consisting largely of fish scales cemented by darker collophane. Plane-polarized light. Phosphoria Formation, Permian, Idaho, USA.

## 3. GUANO

- Thick phosphate deposits result from the accumulation of bird excrement.
- Leaching of the fresh guano leaves an insoluble residue composed mainly of calcium phosphate.
- The downward percolation of solutions derived from guano may cause phosphatization of underlying carbonates.

## **SEDIMENTARY IRON DEPOSITS**

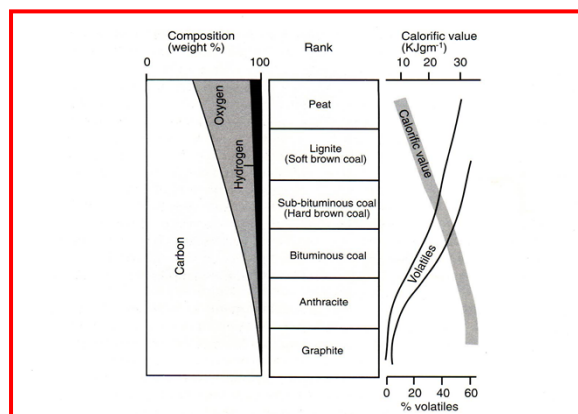
- Iron present in all sedimentary rocks to the extent of a few percent.
- It forms ironstones where the iron content exceed 15%.
- The common iron minerals in sedimentary rock are:
  - hematite, magnetite, glauconite, siderite, pyrite etc...
- The sources of iron for ironstones: continental weathering and volcanicity.
- The precipitation of iron minerals is controlled by Eh, pH, activities of carbonates ions and sulphur.

## **Coal and Peat**

- Coal and peat are traditional fossil fuels which are extracted, transported and burned to produce energy without recourse to processing.
- Both materials are products of the accumulation of organic matter (land plants) in a humid swampy environment (anaerobic depositional environment).

## Formation of Coal Deposits

- The first combustible product formed under suitable conditions is **peat**.
- Peat can form at the earth's surface and composed of partially **decomposed and compressed plant matter**.
- Further burial, with more heat, pressure, and time, gradually dehydrates the organic matter and transforms the spongy peat into soft, brown coal (**lignite**) and then to the harder coals (**bituminous coal and anthracite**).
- As the coals become harder (their carbon content increases) as the amounts of heat released are high.



**The change in the characteristics of coal with increasing rank or maturation**

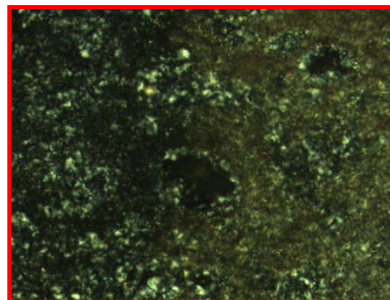


## Siliceous Rocks

- Chert is a very general term for finely crystalline siliceous rock, of chemical, biochemical or biogenic origin.
- It is very hard rock, which splinters with a conchoidal fracture when struck.
- Flint: used frequently as a synonym for chert nodules occurring in Cretaceous chalks.
- Jasper: refers to a red variety of chert, its colour being due to finely disseminated hematite. Chert in this type is interbedded with iron minerals.
- Porcelanite: refers to siliceous rocks with a texture and fracture similar to unglazed porcelain. Also used for an opaline claystone.

## Chert

- Most bedded chert are primary accumulations.
- Many nodular are diagenetic, formed by replacement.
- Bedded and Nodular cherts consist of three types of silica:
  1. *Microquartz*
  2. *Megaquartz*
  3. *Chalcedonic quartz*



## Origin of Chert

- Chert may be of organic or inorganic origin
- Organic chert is produced by the accumulation of **Radiolaria** (marine zooplankton with a range of Cambrian to Recent), **diatoms** (marine and non-marine phytoplankton, Triassic to Recent) and **siliceous sponges** (marine and non-marine, Cambrian to Recent).
- Inorganic chert is produced by the dissolution of detrital quartz grains, clay minerals volcanic rocks and rock fragments at high pH (Alkaline conditions) so that the water become supersaturated with respect to amorphous silica. The lowering of pH (Acidic condition) causes silica to be precipitated which would give rise to chert on maturation.

